Rule-Governed Behavior: Teaching a Preliminary Repertoire of Rule-Following to Children With Autism

Jonathan Tarbox, Carrie K. Zuckerman, Michele R. Bishop, and Melissa L. Olive, Center for Autism and Related Disorders
Denis P. O'Hora, National University of Ireland, Galway

Rule-governed behavior is generally considered an integral component of complex verbal repertoires but has rarely been the subject of empirical research. In particular, little or no previous research has attempted to establish rule-governed behavior in individuals who do not already display the repertoire. This study consists of two experiments that evaluated multiple exemplar training procedures for teaching a simple component skill, which may be necessary for developing a repertoire of rule-governed behavior. In both experiments, children with autism were taught to respond to simple rules that specified antecedents and the behaviors that should occur in their presence. In the first study, participants were taught to respond to rules containing ''if/then'' statements, where the antecedent was specified before the behavior. The second experiment was a replication and extension of the first. It involved a variation on the manner in which rules were presented. Both experiments eventually demonstrated generalization to novel rules for all participants; however variations to the standard procedure were required for several participants. Results suggest that rule-following can be analyzed and taught as generalized operant behavior and implications for future research are discussed.

Key words: rule-governed behavior, rule-following, instructional control, conditionality, autism, relational frame theory

Applied behavior analysis is a science that endeavors to solve problems involving socially important behavior by identifying the variables of which such behavior is a function, thereby allowing for its prediction and control (Cooper, Heron, & Heward, 2007). Behavior may be easiest to control when the environmental variables, of which it is a function, are readily apparent and/or are to be found in the recent history of the person (Skinner, 1974). A special class of behavior, however, defies efforts at the identification of immediately apparent environmental contingencies that are responsible for its occurrence, namely, that of rule-governed behavior (RGB). RGB is behavior that occurs due to contact with rules that describe contingencies, and *not* due to prior contact with the contingencies the rule describes (Skinner, 1969). For example, one can respond effectively to the rule ''If you drink bleach, you will die,'' without ever having to directly contact the contingencies, that is, without ever having to engage in the behavior of drinking bleach or of contacting the consequence of dieing. By definition, one can ''follow'' a rule, without ever having contacted the contingencies that it describes.

Skinner (1974) described RGB as particularly crucial for the existence and maintenance of human civilization. RGB is important because it allows humans to respond effectively in life without having to directly contact contingencies that would be destructive or inefficient to contact. Rules allow one to avoid dangerous consequences for behavior (e.g., the rule ''Look both ways before crossing the street''). Rules also allow one to profit from the experience of previous generations by contacting rules that previous generations have derived through their contact with contingencies. The laws of science are such rules (Skinner, 1969, 1974). For example, the principle of reinforcement can be taught to a university student or clinician and it can be applied immediately. It is not necessary for each new person to discover the principle of reinforcement through random contact with contingencies in the laboratory. The same may be said of the

The authors would like to thank Ben Craighead for his contributions to the study. Address correspondence to Jonathan Tarbox, PhD, BCBA-D, 19019 Ventura Blvd, 3rd Floor, Tarzana, CA 91356. (E-mail: j.tarbox@centerforautism.com).

laws of physics, biology, chemistry, and engineering. Each new engineer need not discover through direct contact with the consequences of their behavior how to build a bridge that will not fall down. RGB is therefore among the most important, foundational classes of behavior for human civilization and modern life, as we know it would be impossible without it.

Despite the importance of RGB, relatively little attention has been paid to it in the behavior analytic literature. While Skinner's books include the bulk of early behavioral work on the topic, his conceptual analyses of RGB vary somewhat across his writings. In some places, Skinner described rules as stimuli that altered the operant and/or respondent properties of other stimuli (1957, p. 359), sometimes referring to these as ''contingency-specifying stimuli'' (1969, p. 169), although specification, per se, was generally left unaddressed (Hayes, 1991; Parrott, 1984). In other places, Skinner described rules as discriminative stimuli (1969, p. 148), presumably because they control behavior ''as though'' they were discriminative stimuli, despite the lack of an appropriate history of differential reinforcement that defines the concept of the discriminative stimulus. Regardless, the general thrust of Skinner's writings suggested that people engage in RGB because they have a history of reinforcement for doing so (1957, 1969, 1974). Generally, then, it might be stated that rule-following can be conceptualized as a class of behavior, in itself.

Empirical research on RGB was active in the 1980s, centering around the work of Charles Catania and colleagues. The research conducted in that period generally focused on such topics as identifying whether operant behavior was primarily rule-governed or contingency-shaped (Shimoff, Mathews, & Catania, 1986), comparing effects of rules that described performance versus those that described contingencies (Mathews, Catania, & Shimoff, 1985), or studying the differences between the properties of rule-governed and contingency shaped behavior, such as differences in sensitivity to changes to contingencies (Shimoff, Catania, & Mathews, 1981; see also Hayes, 1989, for a collection of conceptual papers commenting on early empirical work on RGB). This body of research was an important first step in an empirical examination of RGB but conceptual and empirical research had generally not attempted a functional analysis of the controlling variables involved in RGB, nor an analysis of how the ability to follow rules may be established (Hayes, Blackledge, & Barnes-Holmes, 2001).

In an early conceptual treatment of reference and understanding, Parrott (1984) argued that the behavior of simply complying with a rule is not equivalent with understanding the rule. A person may hear a rule and not understand it (as in hearing a rule in a foreign language) or may hear a rule, understand it, and not comply for other reasons (e.g., the person has no history of complying with rules stated by that particular speaker, etc.). In the first case, the person does not understand the rule, in the second case, he does. Put another way, in the first case, the rule specifies nothing, while in the second case, the contingencies specified by the rule are clear (albeit, not effective).

Conceptual work in recent years has analyzed RGB from the perspective of relational frame theory (RFT). Space does not permit a full conceptual treatment of an RFT analysis of RGB (see Barnes-Holmes, O'Hora, Roche, Hayes, Bisset, & Liddy, 2001; Tarbox, Tarbox, & O'Hora, 2009), but a brief overview should suffice. The foundation of an RFT analysis of RGB is consistent with Skinner's basic position, namely, that rule-following can be conceptualized as an operant. However, RFT provides further elaboration on an analysis of the behavior/environment relations involved in RGB, as well as analyzing how such a repertoire can be acquired, as we describe below.

Relational frame theory conceptual treatments of RGB have provided a functional analysis of what it means when a rule ''specifies'' a contingency. The environmental events, which a rule ''specifies'' for any given person, are the environmental variables that participate in relational frames with the stimuli in the rules, for the particular person listening to the rule. Consider the rule ''If it's raining, then take an umbrella, and you won't get wet.'' The stimulus ''raining'' participates in an equivalence relation (or frame of coordination) with the actual sights and sounds of rain, the stimulus ''take an umbrella'' participates in an equivalence relation with the actual behavior of taking an umbrella, and the stimulus ''won't get wet'' participates in an equivalence relation with avoidance of the aversive condition of wetness. These equivalence relations account for specification of the three terms contained in the contingency but not the contingency itself. In other words, if the rule consisted simply of ''raining take an umbrella won't get wet,'' the rule would not make much sense—it would not specify that rain is the *antecedent* in the presence of which one should take the umbrella (the behavior), nor that avoiding wetness would be the *consequence* of taking it.

According to an RFT analysis, the person following the rule must respond to the *relations between* the words contained in the rule for the antecedent, behavior, and consequence, not merely those words themselves. The ability to respond to conditional relations between stimuli is said to be established, like all other relational operants, via a history of reinforcement of multiple exemplars (Hayes, Fox, Gifford, Wilson, Barnes-Holmes, & Healy, 2001). For example, a parent may say, ''*If* you clean your room, *then* you can go play,'' ''*If* you finish your dinner, *then* you can have dessert,'' ''*If* you do your homework, *then* you can play video games,'' and so on, for many exemplars, all of which vary, but all of which contain the following two elements that remain constant: (1) the contextual cue ''If / then,'' and (2) the consequence delivered contingent upon compliance with the rule. After a sufficient number of such exemplars has been reinforced, the generalized operant behavior of responding to the conditional relations between events emerges, such that novel behaviors and consequences can then be stated with the ''if/then'' cue, and the child can respond appropriately, despite never having received reinforcement for complying with that particular rule in the past. Put another way, after a sufficient history of multiple exemplar training, the contextual cue comes to have discriminative control over correct responding to novel rules (rules containing novel combinations of antecedents, behaviors, and consequences), as long as the rule contains that contextual cue.

It should be noted that the topography of the contextual cue (e.g., ''if/then'') is irrelevant, so long as that particular cue was present in the past during a sufficient history of multiple exemplar training. A fully developed repertoire of rule-following presumably contains several such contextual cues. In other words, the same rule can be stated in several different ways. In the following example, three different rule statements contain slightly different contextual cues (italicized), but all specify the same contingency relation: ''*If* you clean your room, *then* you get television,'' ''*First* clean your room, *then* you get television,'' or ''Clean your room *if* you want to watch television.'' The particular topographies of stimuli that serve as contextual cues, or said another way, discriminative stimuli for the behavior of responding to conditional relations between stimuli (or any other relations) are presumably relative to the particular culture and language in which a listener acquired a verbal repertoire.

The RFT functional analysis of rule-following and the history of multiple exemplar training (MET), which likely establishes it, is inherently practical and empirically testable. Additionally, no research has yet been done that has attempted to establish such a repertoire in someone who does not already display it. Most or all RFT research on RGB has examined its properties in people who already readily demonstrate it, e.g., college students (O'Hora, Barnes-Holmes, Roche, & Smeets, 2004). However, recent evidence suggests that other relational operants may be trainable via MET. For example, two recent studies by Greer and colleagues demonstrated that a procedure for training both speaker and listener responses in children with autism, across multiple exemplars of stimuli, produced generalized naming (ability to respond as both a speaker and listener to novel, untrained stimuli [Horne & Lowe, 1996]), when simply taught to match those stimuli in the presence of the vocal name for them (Fiorile & Greer, 2007; Greer, Stolfi, Chavez-Brown, & Rivera-Valdez, 2005). Similarly, Barnes-Holmes, Barnes-Holmes, Roche, and Smeets (2001) used MET to establish the generalized ability to derive symmetrical relations between actions and objects in typically developing preschool children. Thus, the initial evidence supporting the use of MET for establishing relational operants is encouraging, and there is no reason to believe relational operants of conditionality might not also be amenable to instruction via MET.

The purpose of the current study was to investigate a procedure for establishing a generalized ability to respond to simple rules in children with autism who displayed no evidence of a rule-following repertoire. In specific, two experiments investigating variations on an MET procedure were conducted, in which children with autism were taught to respond to rules specifying antecedents and behaviors. The critical outcome of the study was to demonstrate generalization of the ability to follow rules for which participants had never contacted the specified contingencies, the defining characteristic of RGB.

EXPERIMENT 1

Method

A concurrent multiple probe across participants design (Kazdin, 1982) was used. In order to assess the number of exemplars required to produce generalization, generalization probes were included after each trained rule was mastered.

Participants, Setting, and Materials

Three boys with autism participated. All children were clients of a community-based agency that provided home-based early intensive behavioral intervention services. David was 5 years old and had been receiving 40 hours of therapy per week for 25 months at the start of the study. Frank was 3 years old and had been receiving therapy for 25 hours per week for 19 months. Joey was 5 years old and had been receiving therapy for 18 hours per week for 17 months. All participants had significantly developed repertoires of tacts, mands, and basic one-step instructions. Caregivers of all participants reported that they could not follow simple rules and that the establishment of this ability was a clinical priority. All procedures were implemented as a part of the child's regularly scheduled behavioral intervention program in his/her home. The child was seated at a table with the behavioral therapist who was implementing the teaching program. An additional behavioral therapist or research assistant was often present in order to collect interobserver agreement data and to ensure treatment integrity.

Prior to the study, probes were conducted to confirm that the participants could correctly tact and receptively identify each of the stimuli used in the study. Probes were also conducted to ensure that the participants could correctly respond to the simple instructions used in the study such as, ''Clap your hands.'' Correct responding to these probes resulted in verbal praise. One probe of each tact and each instruction was conducted. Stimuli and instructions were only included in the study if the participant responded correctly to the single probe for it.

Response Measurement and Interobserver Agreement

A correct response was defined as engaging in the behavior specified in the rule when the antecedent stimulus that the rule described was present (i.e., the therapist presented that stimulus and not a different one) and not engaging in the specified behavior when the antecedent stimulus was not present. Interobserver agreement (IOA) was assessed by having two independent observers collect data simultaneously during 21%, 32%, and 74% of sessions for David, Frank, and Joey, respectively. IOA was calculated for each participant, on a trial-by-trial basis, by dividing the number of trials that the two observers agreed upon by the total number of trials, and multiplying by 100. Mean IOA for David was 98% (range = 83–100%), 98% for Frank (range = 80–100%), and 98% for Joey (range = 92–100%).

Procedures

Baseline. During baseline, a card containing a picture of an antecedent stimulus and rule were presented. Table 1 depicts the rules that were presented during both *baseline* and *training* phases. A presumably neutral consequence (e.g., ''Okay'') was given for any response on the part of the participant.

Table 1
Rules Presented During Baseline, Training, and Generalization Probes in Experiment 1

Baseline and generalization probes	Directly trained
If this is orange then touch your head	If this is a carrot then clap
If this is a pig then arms up	If this is a triangle then turn around
If this is a shoe then touch the floor	If this is a ball then stomp
If this is a chair then knock	If this is a cookie then jump
If this is a spoon then stand up	If this is a hat then stick out your tongue
If this is a car then wave	If this is a bike then touch your nose
	If this is a cup then show me laughing
	If this is an apple then touch your ears
	If this is a square then clap
	If this is a motorcycle then stomp
	If this is a cracker then turn around

During half of the trials, the stimulus described in the rule was presented. During the other half of the trials, a stimulus that was not described in the rule (but which *were* described in different rules on other trials) was presented. For example, on one trial, a picture of a car might be held up and the rule presented ''If this is a carrot, then clap,'' whereas on a later trial, the same stimulus (picture of car) would be presented, along with the rule, ''If this is a car, then wave.'' In other words, each rule was presented an equal number of times with the stimulus specified in the rule as absent versus present, and each stimulus included in the experiment was presented an equal number of times with the rule that described it and the rules that did not describe it. Each session consisted of 12 trials, comprised of 6 rules. Each rule was presented for one trial with the antecedent stimulus specified in the rule present and one trial with the antecedent stimulus absent (6 rules × once present plus once absent = 12 trials). The order of rules was random. Trials of mastered items were interspersed and the child received reinforcement for correct responses to mastered items in order to maintain general compliance.

Training. During training, a picture card and rule were presented. Correct responses were followed by a preferred item selected via a brief multiple stimulus preference assessment (DeLeon & Iwata, 1996) conducted prior to each session. Prompts for engaging or not engaging in the behaviors specified in the rules were faded out, within-session, according to the following most-to-least prompt fading hierarchy: (1) full physical: the participant was physically guided to emit the motor response, (2) partial physical: the therapist used light physical touch to guide the participant to emit the motor response, (3) model: the therapist demonstrated the motor response, (4) vocal: the therapist vocally stated the motor response, and (5) no prompt. All correct responses were reinforced, regardless of whether they followed a prompt. Contingent on an incorrect response, the therapist stated ''no'' in a neutral tone of voice, and provided descriptive feedback, such as, ''I said if this is a carrot then clap but look that's not a carrot so don't clap.'' If a participant began to respond before the entire rule was stated, therapists used partial physical guidance (i.e., light physical touch to the participant's hands) so participants would place their hands on their lap. Each time a new rule was introduced, the prompt-fading hierarchy was initiated at the highest level of prompting and prompts were faded within-session. Most-to-least prompt fading was continued on subsequent sessions, until a participant demonstrated correct independent responding on two trials: one trial where the specified stimulus was present and one where it was absent. After meeting this criterion, during subsequent sessions where the same rule was continuing to be trained, the same prompting hierarchy was used, but was implemented in reverse order, according to a within-session, least-to-most sequence. Training sessions consisted of 10 trials.

During half of the training trials the stimulus described in the rule was presented. In the other half of the trials a different stimulus was presented. While the first rule was being trained, sessions consisted of 10 trials. Half of these trials contained the stimulus described in the rule and the other half contained stimuli not described in the rule. After the first rule was acquired, training on it was terminated and training was then conducted on the second rule in the same manner. After the second rule was acquired, all subsequent sessions were 12 trials long. Each time an additional new rule was introduced in training, six trials were allocated to it, with three trials allocated to each of the last two mastered rules. Trials rotated randomly between the three rules that comprised the session.

During all training sessions, the criterion for mastery of a particular rule was set at 80% or more correct across two consecutive sessions. In addition, the participant had to respond correctly the first time the stimulus in the rule was present and the first time the stimulus in the rule was not present, during each session. Once criteria had been met, a generalization probe was conducted.

Generalization probes. Generalization probes were identical to baseline and included only rules that had not been trained. If the participant scored below 80% correct on the generalization probe, training continued with the next rule. If the participant scored over 80% on the generalization probe, training was discontinued and follow-up probes were conducted after one and two weeks. The two week follow-up probe was conducted by a different therapist to show generalization across time (maintenance) and generalization across people.

Altered rule presentation format. This phase was identical to the training phase, except in how rules were stated. Rules were presented so that the behavior was described before the antecedent was specified, as in ''Clap if this is a carrot,'' instead of ''If this is a carrot, then clap.'' This phase was introduced because it was hypothesized that this format of rule presentation may make the antecedent described in the rule more salient because it is the last stimulus presented in the rule.

Altered generalization probe format. This phase was identical to the generalization probes, except that rules were stated with the behavior specified before the antecedent, as in the *altered rule presentation format* phase, described above.

Results

Figure 1 depicts the results of Experiment 1 and the top panel depicts results for David. Note that participants had already learned how to perform all the actions described in the rules prior to the start of the experiment, so it was expected that participants would exhibit these actions frequently, even in baseline. Therefore, because the stimulus specified by the rule was present during 50% of trials, if the child simply emitted whatever motor response was described in the rule on every trial, regardless of whether the specified antecedent stimulus was in place, his behavior would be 50% correct. Accordingly, as the top panel of Figure 1 depicts, David's correct responding was consistently low in baseline (25–42%). David acquired the first rule in the training phase after 15 sessions. Generalization was then probed and found to be absent. Additional rules were then trained and generalization was again probed after each rule was acquired. Generalization was not clearly demonstrated until David was trained on 11 rule exemplars. Correct responding maintained at the one and two week follow-up generalization probes.

The middle panel of Figure 1 depicts the results for Frank. Frank's baseline data indicate responding between 42 and 58% correct. Frank met criteria for generalization after three exemplars were directly trained but maintenance was not demonstrated at the one week follow-up. A second follow-up probe was then conducted and correct responding remained low, so Frank was trained in additional exemplars. After Frank was trained on four additional exemplars and still did not demonstrate generalization, the *altered rule presentation format* phase was initiated. In addition, after each rule exemplar was mastered, generalization probes were conducted according to the *altered generalization probe format.* Frank met criteria for generalization after two additional exemplars were trained and correct responding remained high at the one and two week follow-up probes, therefore demonstrating maintenance and generalization to another therapist.

The third panel of Figure 1 depicts the results for Joey. During baseline, Joey responded correctly on 33–50% of trials. Joey's training proceeded rapidly and he demonstrated high percentages of correct responding during generalization probes after only two rule exemplars had been trained. These results maintained at a one-week follow-up probe and a two-week follow-up probe with another therapist.

Discussion

Experiment 1 demonstrated that MET can establish the generalized ability to respond to novel rules, consisting of basic contingency statements that specify an antecedent and a behavior in young children with autism. However, generalization to novel rules was only observed in two of three participants and a modification of the procedure appeared to be necessary for Frank. The creation of the *altered rule presentation format* came from the observation that participants generally engaged in the behavior specified in the rule immediately after the rule was stated, regardless of whether the specified antecedent was present. The behavior specified in the rule was the last word stated in the rule so it was hypothesized that, due to the lengthy history of reinforcement for engaging in an action when asked to do so, the antecedent, which was specified in the rule, was not salient because it occurred earlier in the rule statement. In addition, in the standard rule presentation format, the contextual cue ''if'' occurred at the beginning of the rule and may have also been less salient for that reason. Therefore, the *altered rule presentation format* was designed to specify the behavior at the beginning of the rule, so that the word specifying the antecedent and the contextual cue ''if'' occurred closer in time to when the participant had the opportunity to respond. It appeared as though this manipulation aided Frank's acquisition. However, the *altered rule presentation format* was only implemented with one participant, without a valid experimental design, so it was also possible that Frank only needed two more exemplars to be trained, and would have demonstrated generalization by merely continuing with the standard procedure. Further research was needed on the altered rule presentation format, in the context of a valid experimental design, and this was the purpose of Experiment 2.

EXPERIMENT 2

Method

The experimental design was identical to that used in Experiment 1.

Participants, Setting, and Materials

Three boys with autism participated in the experiment, none of which had participated in Experiment 1. Jeremy was 5 years old and had been receiving behavioral intervention services for 20 hours per week for 17 months. Tim was 7 years old and had been receiving treatment for 13 hours a week for 10 months at the start of the study. Greg was 6 years old at the start of the study and had been receiving treatment for 25 months for 30 hours a week. As in Experiment 1, all participants were reported to possess significant repertoires of tacting, manding, and following one-step instructions but none could reportedly follow simple rules. All procedures were implemented as a part of the child's regularly scheduled behavioral intervention program.

Response Measurement and Interobserver Agreement

Correct responding was identical to Experiment 1, with the added requirement that the participant must also emit a vocal response that specified whether or not he should engage in the behavior (e.g., ''That's not a carrot, so I shouldn't clap''). The rationale for adding the vocal requirement to the motor response was that participants who demonstrated generalization rapidly in Experiment 1 were anecdotally observed to engage in vocalizing of this sort, so it was hypothesized that it may help with acquisition. IOA was assessed the same way as in experiment 1 during 67%, 58%, and 49% of sessions for Jeremy, Tim, and Greg, respectively. Mean IOA for Jeremy was 100%, 99% for Tim (range = 92–100%), and 99% for Greg (range = 92–100%).

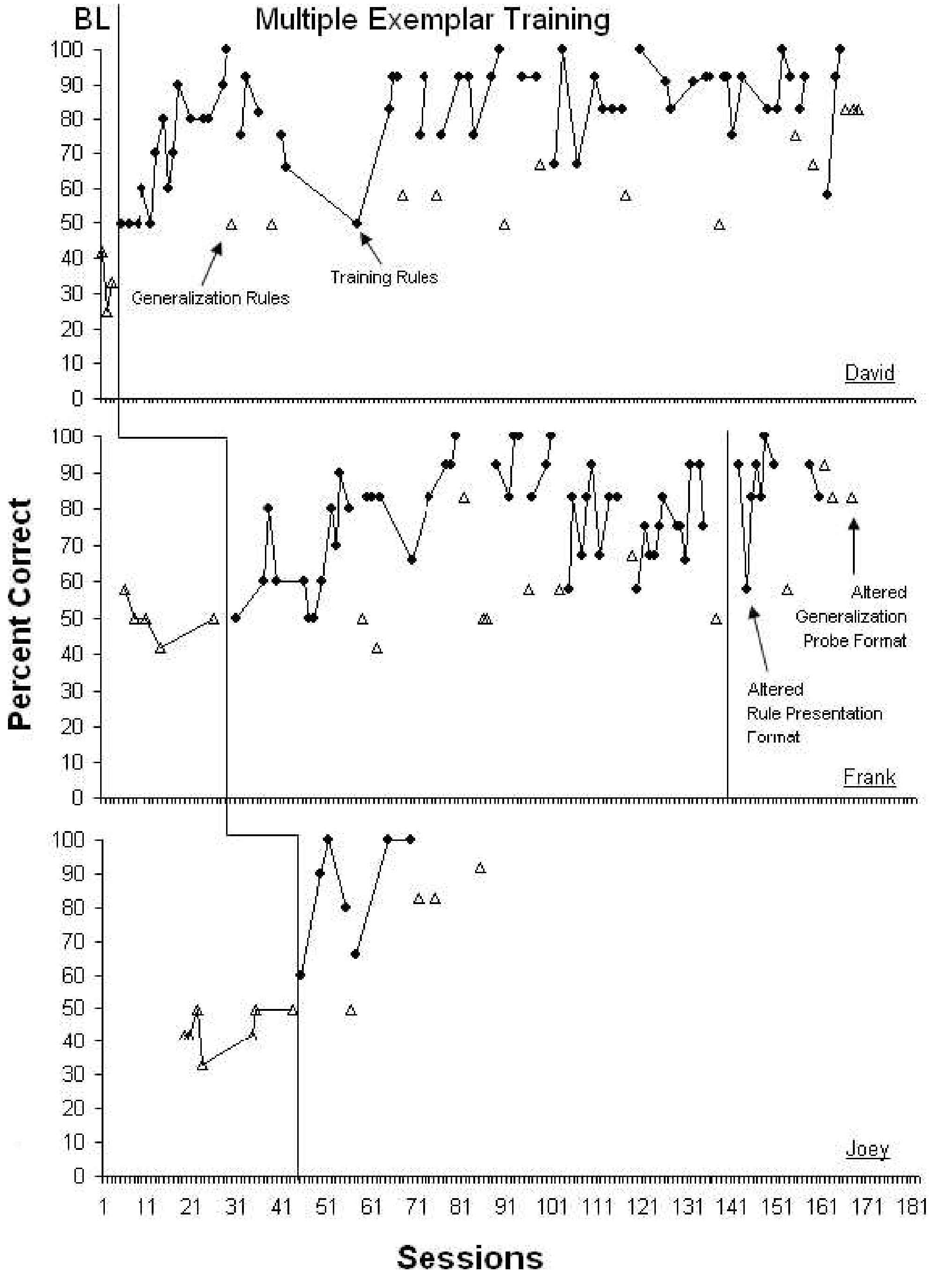

Figure 1. Percentage of correct responses across all conditions of Experiment 1 for David, Frank, and Joey.

Procedures

Baseline. This condition was identical to the *baseline* condition of Experiment 1, with the exception that rules were presented with the behavior specified before the antecedent (e.g., ''Clap if this is a carrot''), as was done in the *altered rule presentation format* and

Table 2
Rules Presented During Baseline, Training, and Generalization Probes in Experiment 2

Baseline and generalization probes	Directly trained
Touch your head if this is orange	Clap if this is a carrot
Wave if this is a car	Clap if this is a ball
Arms up if this is a pig	Clap if this is a triangle
Knock if this is a chair	Stomp if this is a hat
Stand up if this is a spoon	Stomp if this is a cookie
Touch the floor if this is a shoe	Stomp if this is a bike
	Touch your nose if this is an apple
	Touch your nose if this is a square
	Touch your nose if this is a cup
	Turn around if this is a motorcycle
	Turn around if this is a phone
	Turn around if this is a cracker
	Jump if this is a hat
	Jump if this is a triangle
	Jump if this is a cup
	Stick out your tongue if this is a square
	Stick out your tongue if this is a bike
	Stick out your tongue if this is a phone
	Touch your ears if this is a carrot
	Touch your ears if this is a motorcycle
	Touch your ears if this is a cup
	Show me laughing if this is a cookie
	Show me laughing if this is a ball
	Show me laughing if this is a cracker

the *altered generalization probe format* conditions of Experiment 1. Table 2 lists the rules presented during *baseline*, *training*, and *generalization probes* in Experiment 2.

Training. This condition was identical to the *training* condition of Experiment 1, with the exception that rules were presented with the behavior specified before the antecedent, as was done in the *altered rule presentation format*. The number of exemplars presented in each training session also differed from that in Experiment 1. Instead of an individual training rule with a single behavior and stimulus (e.g., ''Stomp if this is a hat'') a single behavior was paired with 3 different stimuli during the session (e.g., ''Stomp if this is a hat,'' ''Stomp if this is a cookie,'' and ''Stomp if this is a bike''). In addition, participants were prompted to engage in a vocal response describing the antecedent present and the appropriate response (e.g., ''That's not a carrot, so I shouldn't clap''). Prompting for the vocal response was identical to that for the motor response (i.e., within-session most-to-least, followed by within-session least-to-most), except that the following hierarchy was used: (1) full vocal model, (2) partial vocal model, (3) no prompt.

Generalization probes. This phase was identical to the *altered generalization probe* condition of Experiment 1.

First trial generalization probes. During these probes, a single trial of an untrained rule was probed. These new rules included behaviors and stimuli that were never included in any previous training sessions or probes (see Table 3). Consequences were identical to the *training* phase. Because differential consequences were delivered for correct and incorrect responding, each rule could only be probed once (i.e., after one trial of a particular rule occurred and consequences were provided for correct or incorrect responding, that rule could no longer be presented as a test for RGB, since RGB is defined as behavior, which is *not* due to prior contact with contingencies). Therefore, generalization was demonstrated if a participant

Table 3
Rules Presented During First Trial Generalization Probes in Experiment 2

Touch your belly if this is a cow
Dance if this is a tree
Stretch if this is an elephant
Touch your feet if this is a bird
Touch your eyes if this is a fish
Blow if this is a banana
Touch your knees if this is a flower
Cough if this is a bed
Touch your mouth if this is a computer
Show me thumbs up if this is a train

consistently responded correctly to the first trials of many (e.g., 10 or more) successive novel rules. In addition, since correct responding was reinforced, each trial was separated by a minimum of 10 minutes, in order to minimize the possibility that correct responding on one generalization probe could be due to maintenance of a recently reinforced trial of a different rule.

Results

Figure 2 depicts the results of Experiment 2. The top panel of Figure 2 depicts Jeremy's data. During baseline, Jeremy's correct responding was variable and low (16–50%). Jeremy met criteria for generalization (83%) after two sets of rules were trained (two behaviors and six stimuli). Maintenance was demonstrated at the one and two week follow-up probes.

The middle panel of Figure 2 depicts Tim's data. During baseline, Tim demonstrated low correct responding (42–50%). Tim did not demonstrate generalization after eight sets of training rules had been acquired. Additional sets of rules continued to be trained, but *first trial generalization probes* were instituted, rather than the standard generalization probes. Tim never responded incorrectly to *first trial generalization probes.* After 14 *first trial generalization probes*, a standard generalization probe session was implemented and Tim's correct responding returned to low levels. Additional *first trial generalization probes* were then conducted and Tim's correct responding returned to 100%.

The third panel of Figure 2 depicts Greg's data. Greg's baseline data were low and variable (25–50%). Greg reached criteria for generalization following one set of training rules (one behavior and three stimuli). Maintenance was demonstrated at the one week follow-up probe. However, correct responding decreased at the two week follow-up when another person administered the probe. Two additional sets of rule exemplars were then trained and Greg continued to demonstrate low levels of correct responding. One *first trial generalization probe* was then conducted and Greg responded incorrectly. An additional set of rule exemplars were then trained and Greg subsequently responded correctly to 8 *first trial generalization probes*, after which time, a standard generalization probe was conducted, during which Greg continued to respond correctly. An additional 12 novel rules were then probed in *first trial generalization probes* and Greg's correct responding remained at 100%.

Discussion

The results of Experiment 2 demonstrated that MET, as initially implemented, established the generalized ability to follow rules containing if/then statements in only one out of three participants. Specifically, Tim and Greg continued to respond incorrectly on generalization probes, despite exposure to training of many rule exemplars. However, experimenters hypothesized that low levels of correct responding to generalization probes may have been influenced by the lack of differential consequences for correct or incorrect responding during those probes. That is, if and when correct responding did occur, it was on extinction. Since the same stimuli were used each time a generalization probe was conducted, and many generalization probes were conducted throughout the course of the study, this essentially amounted to a multiple schedule, in which correct responding during training produced reinforcement and correct responding during generalization probes produced extinction. When analyzed as a multiple schedule, it follows that correct responding would be low in the generalization probes. This potential analysis was supported by the fact that correct responding was high during several

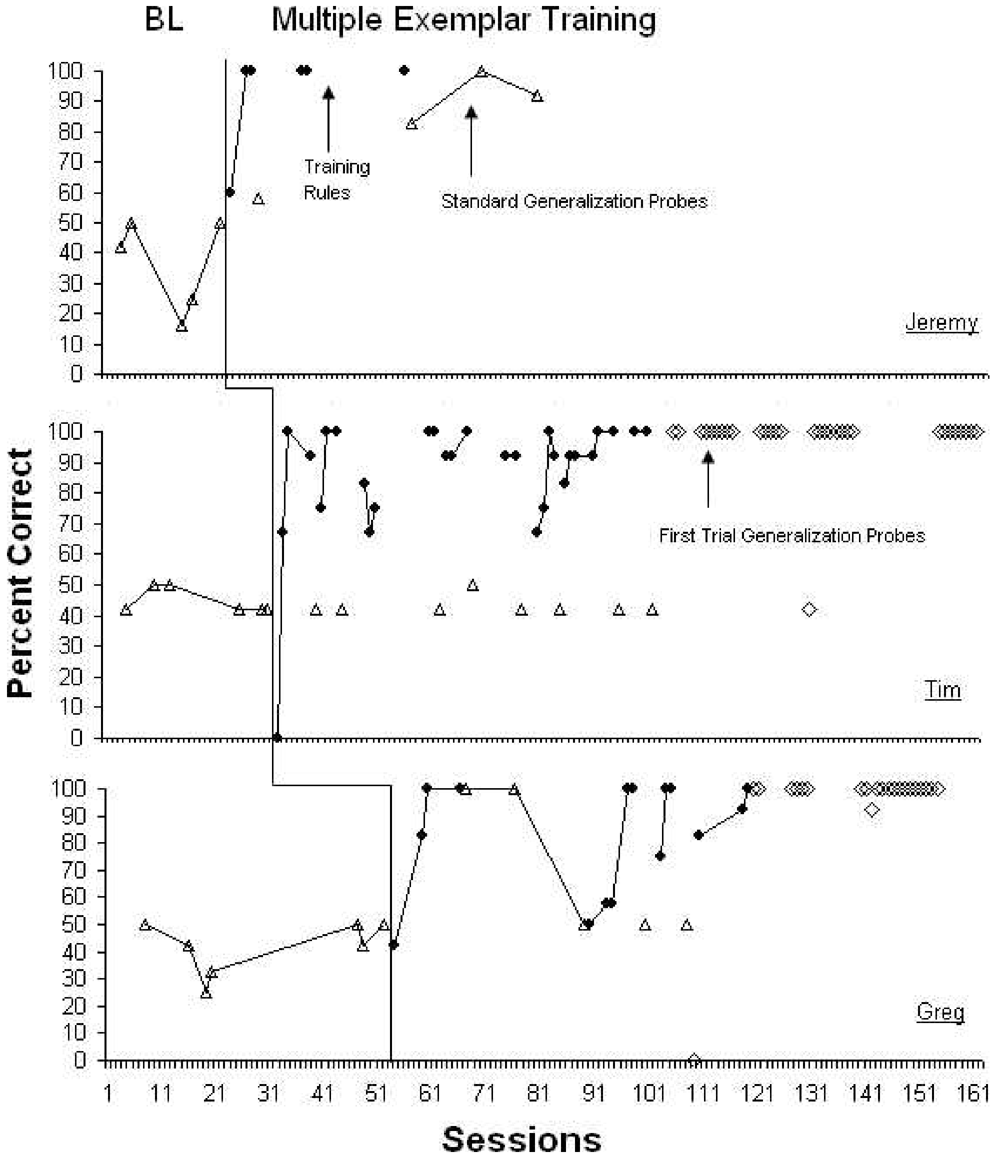

Figure 2. Percentage of correct responses across all conditions of Experiment 2 for Jeremy, Tim, and Greg.

training sessions in which a new exemplar was first introduced, despite the fact that correct responding was low in an immediately preceding generalization probe (e.g., much of Tim's training data). The first trial of a new exemplar during a training session essentially amounted to a generalization probe, in that the participant had the opportunity to independently respond to a novel rule which had not been previously trained and correct responding on that first trial, therefore, amounted to a demonstration of generalization. Such correct responding was frequently observed during training trials, leading experimenters to hypothesize that generalization was indeed occurring, but that the stimuli used during generalization probes (which had been associated with extinction for many previous trials) functioned as S deltas for correct responding.

The *first trial generalization probe* procedure was developed to address this potential problem. These probes allowed experimenters to test generalization without using stimuli that were previously associated with extinction and to allow experimenters to reinforce occurrences of generalization, a procedure that had been previously recommended (Stokes & Baer, 1977). Tim's data support the interpretation that the original generalization stimuli may have been functioning as S deltas because Tim's responding increased to 100% correct immediately upon the introduction of the *first trial generalization probes*. The initial *first trial generalization probe* conducted with Greg produced incorrect responding but all subsequent probes, following the training of an additional set of exemplars, produced 100% correct responding.

GENERAL DISCUSSION

The results of the current two experiments demonstrate that basic behavioral procedures, including prompting and reinforcement, in the context of MET, can establish a generalized repertoire of responding correctly to simple rules. All six children with autism in the two experiments successfully demonstrated a generalized ability to follow novel rules, which contained if/then contingency statements that specified behaviors and the antecedent conditions under which they should occur. To the authors' knowledge, this is the first study to establish any form of RGB in individuals with developmental disabilities who do not already display it.

These results have significant implications for an analysis of RGB as generalized operant behavior. A generalized operant analysis of RGB is congruent with Skinner's suggestion that people follow rules because they have received reinforcement for doing so in the past and it is congruent with the RFT interpretation that RGB consists of generalized relational operants under antecedent contextual control. The RFT analysis, that RGB may be acquired through reinforcement of multiple exemplars of following individual rules, appears to be supported by the current results.

In addition to the potential conceptual implications of the current data, the results of the two experiments offer promising applied implications. Virtually no intervention programs currently exist for establishing RGB in people who do not already display it. The current two experiments are only initial forays into developing procedures for establishing RGB, but they may represent a basic foundation from which to proceed. Future research will be needed that continues to evaluate MET procedures for establishing more complex repertoires of rule-following, eventually extending into something resembling a fully developed adult repertoire of RGB. The rules included in the current two experiments were among the simplest possible examples of rules, in that they specified only the antecedent and the behavior. Future research will need to investigate MET for establishing the ability to respond to rules that specify all three terms of the three-term contingency. The complexity of the rules could be further expanded by including additional terms (e.g., more than one antecedent condition or more than one behavior) and/or by requiring participants to respond to antecedents or consequences in terms of additional relations (including other relational frames). For example, ''Clap if the circle is bigger than the triangle'' or ''Clap if you put on your pants before you put on your shirt this morning'' (Tarbox et al., 2009).

Eventually, research on establishing RGB must move beyond teaching the most basic forms of RGB in children with developmental disabilities, to investigating procedures for establishing repertoires of RGB that typically developing adults possess. For example, little or no published studies have attempted to teach individuals the ability to derive rules. Further, little or no previous studies have attempted to establish the ability to follow rules that specify long-delayed (e.g., death, cancer, retirement, career advancement) or non-existent consequences (e.g., going to hell, going to heaven, etc.).

Several limitations of the current two experiments are worthy of discussion. A significant limitation of the *first trial generalization probe* procedure is the fact that none of the stimuli used in it were probed prior to intervention and therefore low levels of correct responding were not demonstrated during the baseline phase. That is, it is possible that Tim and Greg would have responded correctly to these rules prior to the

MET intervention. However, this possibility appears highly unlikely, given the multitude of trials to which they responded incorrectly to similar rules specifying similar stimuli during baseline and throughout intervention. Nevertheless, future studies should include one trial of each rule to be later used in a *first trial generalization probe*, with no programmed consequence for correct or incorrect responding, during the baseline phase.

A further potential limitation of this study is the fact that experimenters responded by saying ''okay'' in a neutral tone of voice, regardless of participant response during baseline. It is possible that this consequence was not actually neutral and could have served as positive reinforcement during baseline. However, this possibility seems particularly unlikely, given that no upward trends were observed in accuracy during baseline. Furthermore, even if this consequence was a reinforcer, it was delivered noncontingently, so it is unlikely that it would have strengthened correct responding anymore than it would have strengthened incorrect responding. Indeed, in a comparison of various post-testing procedures in a stimulus equivalence experiment, LeBlanc, Miguel, Cummings, Goldsmith, and Carr (2003) found that the inclusion of noncontingent reinforcement during post-testing produced similar results as when post-testing was conducted under extinction.

An additional limitation of the two experiments is that the results obtained were significantly idiosyncratic across participants. One participant in each experiment readily demonstrated generalization to novel rules after being trained on a small number of exemplars. However, the other four participants either required training on many exemplars across a long period of time (David) or required a modification to the basic procedure (Frank, Tim, and Greg). It is not possible to determine the cause of the idiosyncratic results from the current data but it was likely due to differences among reinforcement histories and current repertoires of the participants at the time the studies were initiated. For example, there are likely prerequisite skills that are necessary before MET in rule-following is likely to be successful. Future research should attempt to empirically identify what these skills are.

Another potential strategy for avoiding participant variables, which may prevent the acquisition of RGB, may be to include typically developing children as participants, rather than children with developmental disabilities. Typically developing children do not require explicit intervention in order to develop repertoires of RGB, so such research may be less socially valid, but it may provide a more convenient research context in which to study the basic processes involved in the establishment of rule-following repertoires.

A significant limitation to the current study is the fact that, although generalization to novel rules was demonstrated for all participants, no attempt was made to assess generalization of rule-following to rules that participants contacted in the course of their day-to-day life. That is, generalization of the basic ability to understand and respond to if/then contingency statements was demonstrated but it is not known if generalization occurred on a broader basis. The purpose of the current two experiments was to conduct an initial evaluation of whether establishing a basic component skill of rule-following was possible via MET, not to assess real-life generalization, however future research should attempt to ensure that treatment gains are applied across participants' everyday lives.

The two experiments in the current study demonstrated that MET can be used to establish the generalized ability to follow simple rules, containing if/then contingency statements that describe antecedents and behaviors. This is the first study, of which the authors are aware, where the primary purpose of the study was to establish RGB in individuals who do not already display it. Further, the results of this study demonstrate that such a repertoire can be established in children with autism. However, this study is not without its limitations and future research is needed to identify prerequisite skills so that participants can be appropriately matched to training procedures and more consistent positive results can be obtained.

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